"MACHINE FOR HANDLING TUBULAR KNITTED ARTICLES, SUCH AS SOCKS OR THE LIKE"

DESCRIPTION

Technical Field

The present invention relates to a machine for handling socks or other tubular knitted articles, in particular to perform operations preliminary to loading the socks on a sewing machine.

Prior art

To produce both men's and women's socks one of the most complex operations which requires a high incidence of labor is sewing of the toe. In fact, the sock is normally delivered from the circular knitting machine on which it is produced with both ends open: both the elastic edge or band, and the toe which must subsequently be closed by means of a sewing or linking operation.

In articles of greater prestige the toe is closed manually by linking. However, this operation has a high incidence on the final cost of the product and is therefore only performed on special products and increasingly less frequently.

Machine sewing reduces the cost of the finished article, but nonetheless requires a high incidence of labor, as normally the sock with the toe open is inserted in the guide of the sewing machine with a manual operation. Various devices have been devised to simplify and automate at least a part of the operations preliminary to sewing. However, satisfactory results have not yet been reached.

US-A-5040475 describes a complex machine which picks up socks placed in bulk in a basket and loads them automatically on tubular members which then cooperate with the sewing means. This machine is particularly complex and costly.

Other devices for handling socks to perform closing of the toe are described in US-A-6,209,363; US-A-6,003,345; US-A-6,158,367; US-A-5,165,355 and in the Italian patent application FI2002A000224.

Objects and summary of the invention

The object of the present invention is to produce a machine for handling socks, and in particular to prepare them automatically for sewing,

which is simpler and more reliable than prior art machines.

This and other objects and advantages, which shall be apparent to those skilled in the art from reading the text hereunder, are obtained in substance with a machine comprising: at least one tubular member to transport the articles; a container in which said articles are placed in bulk; pick-up members to pick up individual articles from said container; a feed path of the articles; detection means to identify the orientation of the articles along said path; a stretching device to stretch open an end of an article and load said article onto said tubular member. The machine also comprises members to discard articles oriented with the first end farther forward than the second end with respect to the direction of feed of the article along said path, and to feed toward said stretching device articles oriented with the second end farther forward than the first end with respect to said direction of feed.

Therefore, contrary to other known machines, the machine according to the invention does not have complex members to dispose the articles in the correct orientation, in which they must be arranged in order to be loaded onto the tubular transport member, which then conveys the article through the various machine stations. Much more simply, the machine recognizes the (random) orientation of the article and handles only those fed with the correct orientation, while the others are discarded and returned to the container.

As shall be apparent from the description hereunder, correct orientation of the article depends on the operations to be performed thereon and on the structure of the machine.

In a possible configuration, wherein the articles are picked by pick-up means, engaged at the elastic band, stretched and loaded directly onto the tubular member, they will be correctly oriented when the end of the article in the farther back position along the feed path, along which orientation is detected, is the band. In this case, all articles fed with the band oriented toward the back, that is farther back than the toe with respect to the direction of feed, will be picked up and loaded on the tubular member, while the others will be discarded.

In a different embodiment of the machine, correct orientation of the article can depend on the type of article and consequently on the operations to be performed subsequently thereon. In this case, correctly oriented articles

can be those fed with the band being the leading end , or with the toe being the leading end, depending on whether these articles are delivered from a single or double cylinder circular knitting machine.

Therefore, in general "first end" may be intended alternatively as the toe or the band, depending on the type of article and type of machine.

As statistically about half of the articles will be fed oriented correctly and the other half will be presented oriented incorrectly and therefore must be discarded, to reach an adequate production rate it may be advisable in some cases to provide more than one pick-up member, that is, multiple pick-up members, for example double, or even triple or quadruple.

Alternatively to or in combination with multiple pick-up members, a magazine to store the correctly oriented articles may be provided.

In a possible embodiment of the invention, the detection means are disposed along a trajectory of the pick-up members, said pick-up members being controlled to hold the articles oriented with the second end farther forward than the first end (i.e. with the toe farther forward than the elastic band) and release into the container articles oriented with the first end farther forward than the second end.

The pick-up members will in this case be disposed to move according to a preferably vertical trajectory.

In a further configuration of the machine, a conveyor can be disposed along the feed path of the articles, on which the articles picked up from said container by means of the pick-up members are placed; the detection means can in this case be advantageously disposed along said conveyor. Advantageously, in combination with said conveyor, a recirculation path can be provided, for example of the pneumatic type, extending from a position along the feed path of the articles toward the container. Means can be disposed in the recirculation path to make the articles fall into the container in a preferential position, to facilitate correct pick-up by the pick-up members during the subsequent cycle.

Preferably, the machine comprises an assembly rotating about an axis (e.g. horizontal or preferably vertical) carrying a plurality of tubular transport members, to make them advance stepwise through a plurality of stations, having different functions. The number and type of stations and the members

of which they are composed can differ. It would also be possible for a part of the stations to be replaced by machine operators, although it is clearly preferable for all operations to be performed automatically.

In a possible configuration the machine comprises a loading station, in which the stretching device is disposed. The loading station can comprise at least one pair of retaining elements of the elastic band of the articles, movable in relation to each other, so that they can move toward and away from each other, said retaining elements engaging the elastic band of said tubular article to open it and prepare it to be picked up by said stretching device. The pairs of retaining elements can also be two or more, cooperating with several stretching devices. Alternatively and preferably, the stretching member is one and is produced to pick up tubular articles from one or from the other of two or more pairs of retaining elements.

According to a different aspect, the invention relates to a method to feed knitted tubular articles having a first end and a second end to a work station, comprising the steps of:

- picking up individual articles from a plurality of articles disposed randomly in a container;
- feeding the articles along a feed path toward a work station;
- for each article, determining which of said first and said second end is the leading end along said path, with respect to the direction of feed;
- feeding the articles oriented with the second end farther forward with respect to the first end to said work station and discarding the articles which are oriented with the first end farther forward than the second end.

Further advantageous features and embodiments of the machine and of the method according to the invention are indicated in the appended claims and shall be described in greater detail hereunder with reference to some embodiments

Brief description of the drawings

The invention shall be better understood by following the description and accompanying drawing, which shows possible embodiments of the invention. More specifically, in the drawing:

Figure 1 shows an axonometric view of the machine;

Figure 2 shows a plan view of the machine;

Figure 3 shows a side view according to III-III in Figure 2;

Figure 4 shows an enlargement of the pick-up area of the tubular articles picked up from the container or basket;

Figure 5 shows an axonometric view of the station to load the articles onto the tubular members;

Figure 6 shows an axonometric view of the feeder that carries the articles to the loading station;

Figure 7 shows an axonometric view of a part of the members to load the articles onto the tubular members;

Figure 8 shows an axonometric view of the members to engage and stretch the elastic band of the articles;

Figures 9A-9K show an operating sequence to handle and load articles delivered from a double cylinder circular machine;

Figures 10A-10T show an operating cycle to handle and load articles delivered from a single cylinder machine;

Figures 11A, 11B show axonometric views of the head of the second station of the machine;

Figures 12 to 14 show side views of the operating sequence of the head in Figures 11A, 11B;

Figures 15A-15E show a front view of the operating sequence for angular positioning of the toe pocket;

Figures 16 to 18 show side views and a view according to XVII-XVII in Figure 16 of the members of the third station of the machine;

Figures 19 and 20 show axonometric views of the fourth station of the machine;

Figures 21 and 22 show side views according to XXI-XXI and XXII-XXII in Figure 23;

Figure 23 shows a plan view of the head in Figures 19, 20;

Figure 24 shows an axonometric view analogous to the view in Figure 20 in a different layout of the head members;

Figure 25 shows a plan view analogous to the view in Figure 23, with the members in the layout of Figure 24;

Figures 26 to 28 show cross sections of the pick-up members of the end edge of the tubular article;

Figure 29 shows an axonometric view of a portion of the head in Figure 24, with parts removed;

Figures 30 to 33 show side and axonometric views of the tubular member and of the inner tabs;

Figure 34 shows a side view of the head of the last station of the machine with the article being processed;

Figures 35 to 38 show cross sections of the pick-up members of the edge of the article in various working positions;

Figure 39 shows a plan view of a modified embodiment of the machine according to the invention;

Figure 40 shows an axonometric view of the station to load the tubular knitted articles onto the tubular members;

Figure 40A shows an enlargement of a detail in Figure 40;

Figure 41 shows a side view of the loading station;

Figure 42 shows a view according to XLI-XLI in Figure 40;

Figure 42B shows an enlargement of a detail in Figure 42;

Figures 43A, 43B show axonometric views in two distinct layouts of the mechanism to engage the tubular articles;

Figures 43C, 43D show front views of the mechanism in Figures 43A, 43B in the two layouts;

Figure 43E shows an enlargement of a detail in Figure 43A;

Figures 44A-44G show an operating sequence of the loading station in the embodiment in Figures 39 to 43; and

Figure 45 shows an axonometric view of the principal elements of the reversing station of the machine in Figure 39.

Detailed description of preferred embodiments of the invention

The machine, indicated as a whole with 300, is shown in a perspective view in Figure 1, in a plan view in Figure 2 and in a side view according to III-III in Figure 3. With initial reference to these figures, the general configuration of the machine and the arrangement of the means to load the individual articles onto the tubular transport member will firstly be illustrated.

The numeral 301 indicates a container or basket rotating about a vertical axis, into which the socks or other tubular knitted articles to be handled are unloaded in bulk. The numeral 303 schematically indicates a sewing machine

of a known type. The object of the machine 300 is to pick up the socks placed in bulk in the container 301, orient and position them correctly in the guide or guillotine of the sewing machine 303, all automatically without operations by human beings. The machine comprises a rotating assembly 375, disposed on which are four tubular members 377, over each of which a tubular knitted article M is inserted and which transfer the various tubular knitted articles through a plurality of stations (four in the examples shown in Figure 1), indicated with 428, 430, 432, 434. More specifically, in the station 428 the article M is inserted over the tubular member; in the station 430 the position of the heel pocket or of the toe pocket is detected, to orient the article M about the longitudinal axis; in the station 432 the toe P of the article is made to slide onto the outer surface of the tubular member 377 and disposed approximately on a plane orthogonal to the axis of said member; and in the station 434 the toe is flattened and inserted in a guillotine or guide from which it is subsequently transferred to the guide of the sewing machine 303.

The individual articles are picked up from the container 301 by means of two pick-up devices 305. In the example illustrated the pick-up system is double to allow the machine to operate at the necessary rate, which must be sufficient to feed the sewing machine 303 at an appropriate frequency. It could also be possible to use a single pick-up system or more than two pick-up systems 305.

Each system 305 comprises a gripper or other pick-up member 307, mechanical or pneumatic, mounted on a slider 309 provided with a vertical movement in the direction of the double arrow f309 and moved by a motor 311 by means of a belt 313. At each downward stroke each of the two pick-up members 305 randomly engages, with the gripper 307 thereof, an article M in the basket or container 301 and carries it upwards, passing in front of an optical system indicated schematically with 315 in Figure 4 and equipped, for example, with an optical transmitter and an optical receiver. The optical system 315 controls upward movement of the respective slider 309 to halt the lifting stroke when the article M is in the correct position to be engaged by a second gripper or other pick-up member 317, pneumatic or mechanical, associated with the relative slider 309.

As can be seen in Figure 1 and in Figure 2, the machine has two

grippers 317, one for each of the two sliders 309 and respective grippers 307. The two grippers 317 are carried by moving members 319 which perform an alternate horizontal stroke in the direction of the double arrow f319, being guided on guide bars 321 and connected to belts 323 controlled by suitable electric motors (not shown).

The grippers 317 are provided with an oscillatory movement about an axis 317A (Figure 4) controlled by a piston 325, so that they can take a horizontal position (solid line in Figure 4) and an inclined position (dashed line in Figure 4). In the first position the gripper 317 engages the article M held by the respective gripper 307, while in the second position inclined downwards it releases the article onto a horizontal conveyor 327. The return stroke of the grippers 317 toward the grippers 307 takes place by lifting the grippers 317 from the conveyor 327, to prevent them from interfering from the article M placed thereon.

With this arrangement the socks or articles M picked up each time from the grippers 307 and engaged by the grippers 317 are laid on the horizontal conveyor 327 which conveys them in the direction of the arrow f317 toward a control station 329, in which the operations described below are performed.

Thanks to the presence of the optical sensor 315, which controls operation of the grippers 307 and 317, each article M is engaged by the respective gripper 317 in proximity to the lower end thereof. This may either be the toe P or the elastic band B of the article. The article can also be engaged in an intermediate position by the gripper 307, as the articles M are placed in bulk in the basket or container 301. In any case, the gripper 317 engages the article M at the end thereof with the lower position and which consequently is last to pass in front of the optical sensor 315.

The purpose of the control station 329 is to check orientation of the articles M laid down by the grippers on the horizontal conveyor 327. In substance, the station 329 determines, for each article M fed through said station whether it is disposed with the toe P being the leading end or with the band B being the leading end with respect to the direction f327 of feed. As shall be apparent hereunder, the machine is produced so that only the correctly oriented articles M are processed. Correct orientation required for the subsequent operations to prepare for sewing depends on the type of

article handled. In fact, as will be explained below, the type of handling to which the article M is subjected in the machine 300 differs according to whether the article is delivered from a double cylinder circular knitting machine or from a single cylinder circular knitting machine. In the first case, the articles M in the basket or container 301 are already reversed and therefore the machine 300 does not need to perform the reversing operation prior to sewing, which must be performed with the article reversed. On the other hand, when the articles M are socks delivered from a single cylinder circular knitting machine, the first operation the machine 300 must perform is to reverse the sock. Consequently, the individual articles M must be fed to the subsequent members of the machine oriented in one or other direction, depending on whether they must be reversed prior to sewing.

In this particular case, when the articles M are reversed socks delivered from a double cylinder circular knitting machine, they must be oriented on the horizontal conveyor 327 so that the toe P thereof is the leading end with respect to the direction of feed f327. On the other hand, if the articles M are delivered from a single cylinder circular machine, they will be oriented correctly when they reach the horizontal conveyor 327 with the band B being the leading end with respect to the direction of feed f327. Figure 2 shows an article M with the toe P being the leading end. This article is correctly oriented when it is an article delivered from a double cylinder circular knitting machine.

Each article M which passes through the station 329 is detected by a sensor or by a series of sensors, either optical or of another type, indicated schematically with 331 in Figure 3. In fact, generally when producing socks or other tubular knitted articles M, around the edge defining the toe P of said article is a band of increased thickness with respect to the fabric forming the remaining part of the article and of a different color. The sensors 331 are consequently able to identify which of the two ends of the article M is the first to reach the station 329.

To facilitate reading the station 329 has a series of wheels 333 which flatten the article before it passes under the sensors 331. The sensors 331 can be of any type. For example, they can be sensors capable of recognizing the color of the band surrounding the toe of the article, or they could be

composed of vision systems with digital cameras or the like, combined with image processing software. If the band surrounding the toe of the article is woven with a special material, for example containing metal, capacitive sensors can also be used. In any case, what is relevant is that sensors are provided in the control station 329, capable of sensing whether each article M is oriented with the toe P being the leading end or with the band B being the leading end.

The machine is produced so that the socks or articles M oriented correctly for subsequent handling are fed to the subsequent station, while those which are not oriented correctly are simply discarded and recycled toward the container 301. In substance, the machine does not carry out any orientation of the article, but merely checks whether the articles picked up randomly from the container or basket 301 are oriented correctly as a function of the type of article being processed. For this reason, as the socks M reach the horizontal conveyor 327 in an entirely random manner, and therefore part of them (statistically half) will be discarded, it is advantageous to use two pick-up devices, to increase the rate of the machine and guarantee operation and correct speed even when, statistically, half of the socks picked up from the basket or container 301 will be discarded. Besides a double pick-up device, as shall be explained hereunder, in this embodiment the machine is also provided with a magazine or buffer of articles in an intermediate position between the station 329 and the station 428 to load the socks or articles M onto the tubular transport members 377.

The horizontal conveyor 327 carries all the articles M which have been fed through the station 329 in front of a pusher 335, which translates each article M in a transverse direction with respect to the direction of feed of the horizontal conveyor 327 to take it onto a surface 337. The alternate movement of the pusher 335 is indicated with f335. Disposed above the surface 337 is a suction mouth 339, which by means of a pneumatic circuit 341 picks up the incorrectly oriented socks or articles M fed to the surface 337 and returns them to the basket or container 301. In substance, when socks delivered from a double cylinder circular machine are to be handled, the mouth 339 will pick up and unload into the container 301 all socks which reach the surface 337 oriented with the band B facing forward instead of with

the toe P facing forward. Instead, when articles delivered from a single cylinder circular machine are to be handled, the opposite will occur. Alternatively, the articles M oriented incorrectly can simply be unloaded at the end of the horizontal conveyor 327, where they can be picked up and returned to the container or basket 301.

On the surface 337 a sort of magazine or buffer of articles forms, and these are made to advance in steps by means of a feeder below, indicated as a whole with 343 and illustrated in particular in Figures 5 and 6. The feeder 343 has a frame 345 provided with alternate movement in the direction of the double arrow f345, controlled by a motor 347 by means of a connecting rod 349. Supported on the frame 345 are shafts 351, disposed on which in turn are idle rollers 353. Intercalated between the idle rollers 353 are oscillating fingers 355. Oscillation of the fingers 355 is controlled by piston-cylinder actuators 357 hinged to the frame 345 and to the shafts 351. The oscillatory movement of the fingers 355 controlled by the actuators 357 carries said fingers alternatively to a position in which they project through slots 359 produced in the surface 337, or to a withdrawn position under said surface 337. The alternate movement in the direction of the arrow f345 of the frame 345 and the oscillating movement of the fingers 355 are independent from each other so that by combining them appropriately the articles placed on the surface 337 by the pusher 335 with each stroke can be made to advance in steps.

The alternate movement of the feeder 343 thus feeds the individual articles toward a work surface 361 movable vertically by means of a piston-cylinder actuator 363. The last feed step of the articles along the surface 337 to the work surface 361 is obtained by means of a further pusher 365 (Figure 7) connected oscillatingly to a slide 367 provided with an alternate movement in the direction of the double arrow f367 controlled by an actuator (not shown). This arrangement allows the feed movement of the last article on the surface 37 to be made temporally independent from to the stepped forward movement of the feeder 343. This renders independent from one another the operation of the members of the machine arranged upstream and downstream respectively of the pusher 365 and of the works surface 361.

The surface 361 can be positioned at various heights, Figures 5 to 7

showing the lowest height of said surface. In this position the surface 361 can cooperate with a suction positioning device 369 connected to a flexible member 371 which, controlled by a motor 373, supplies an alternate movement in the direction of the double arrow f369 to said positioning device.

The positioning device 369 carries an optical sensor or the like (not shown). The optical sensor can, for example, be a receiver which cooperates with a transmitter, located under the surface 361, through a slot 361A produced on said surface. By making the positioning device 369 slide in the direction of the arrow f369 parallel to the surface 361, once the article has been positioned on this surface by the pusher 365, the sensor carried by the positioning device 369 allows identification of the position of the end of the article closest to the carousel or rotating assembly 375 of the machine, which carries four tubular members 377 over which the tubular articles M are inserted.

With this arrangement the positioning device 369 can engage, by means of the suction mouth thereof, the end of the article M disposed on the surface 361 and translate it to bring it in line with a suction mouth 379 provided with a lifting and lowering movement with respect to the plane 361.

As indicated previously, when the articles M are socks coming from a double cylinder circular knitting machine, they are fed to the surface 361 with the elastic band B thereof oriented toward the rotating assembly 375 and with the toe P oriented in the opposite direction. Therefore, they will be carried by the positioning device 369 with the elastic band on the mouth 379 remaining with the toe P resting on the surface 361. Instead, when the articles M are socks delivered from a single cylinder circular machine they will be oriented in the opposite direction. The positioning device 369 will carry them again with the elastic band thereof on the mouth 379, but in this case the toe of each article will be made to translate toward the rotating assembly 375 so that it rests on a secondary surface 381 adjacent to the vertically movable horizontal surface 361, as will be explained in greater detail with reference to an operating sequence illustrated in Figures 10A to 10D.

As can be seen in particular in Figure 7, in addition to the slide 367 the machine has a second slide 383 movable in the direction of the double arrow f383 parallel to the slide 367 and disposed thereabove. The two slides 367

and 383 each carry a respective pick-up member 385 (for the slide 367) and 387 (for the slide 383). These pick-up members, which in the example illustrated are mechanical, but which could, for example, be pneumatic, cooperate with the suction mouth 379 to engage and open the elastic band B of each article M and prepare it for insertion over a respective tubular member 377 according to the sequence which shall be described hereunder. The members 385 and 379 therefore form retaining elements of the elastic band of each article M.

Extending over the surface 337 and parallel to the horizontal conveyor 327 is a belt 389 operated by a motor 391, fixed to which is a slider 393 carrying a stretching device, comprising the members used to engage and stretch the elastic band of the tubular article M and to insert it over the tubular member 377 of the rotating assembly 375 which is in the loading position of the station 428.

The stretching device comprises (Figure 8) four fingers 395 which can be moved toward each other and spread apart and which cooperate with two opposing brackets 397. The fingers 395 are inserted, as will be described in greater detail hereunder, inside the elastic band B of each article to be inserted over the tubular member 377 and spread apart to clamp the elastic band against the brackets 397. The movement imparted by the belt 389 to the slider 393 when the elastic band B of the article is engaged by the fingers 395 against the brackets 397 causes the band B of the article M to be inserted over the tubular member 377 which is in the loading position in the station 428.

In an opposite position with respect to the rotating assembly 375, the machine has a pair of tubes 399 carried by a plate 401 revolving around a horizontal axis parallel to the axes of said tubes 399. The tubes 399 cooperate with the remaining members described hereinbefore when the articles M are constituted by socks produced by single cylinder circular machines and have the function of reversing the article M before loading onto the tubular member 377. When the articles M are delivered by a double cylinder machine, the tubes 399 are removed or withdrawn.

Cooperating with the tubes 399 is a slider 403 similar to the slider 393, connected to a belt 405 which imparts an alternate movement to the slider

403 in the direction of the double arrow f403 (Figure 5). The movement is imparted to the belt 405 by a motor 407.

Engaged with the slider 403 are members essentially identical to those carried by the slider 393 and more specifically a pair of brackets 408 cooperating with four fingers 406, which have the function of clamping the stretched border of the elastic band B of the article M against the brackets 408 when said band is oriented toward the revolving plate 401 instead of toward the rotating assembly 375.

The machine parts described hereinbefore are used to load individual articles onto the tubular members 377 of the rotating assembly 375, which then transfers each article through the separate stations 430, 432, 434, which orient the heel pocket of the individual articles and load them in the correct position on a guide from which the article is subsequently transferred to the guide of the sewing machine 303.

Before describing the subsequent stations 430, 432, 434, through which the articles M are transferred by means of the tubular members 377, the operations to load the articles onto the tubular members 377 in the two cases of an article produced by a double cylinder machine and an article produced by a single cylinder machine will be described with reference to Figures 9 and 10.

Figures 9A to 9K show the loading cycle of the reversed article M delivered from a double cylinder circular machine. In Figure 9A the article M has been transferred, by means of a stepped movement of the feeder 343 and finally with a stroke of the pusher 365, onto the raisable surface 361. The positioning device 369 moves forward in the direction of the arrow f369 to reach the end of the elastic band B of the article M where it is lowered against the surface 361 and, by means of the suction mouth or other pick-up member thereof (for example, mechanical) engages the band B of the article M. With a reverse movement (arrow f369, Figure 9B) the positioning device 369 carries the band B of the article M to the suction mouth 379 which is aligned with the surface 361. Subsequently, the positioning device 369 is disengaged from the article M and moves away, continuing its movement in the direction of the arrow f369 (Figure 9C) toward the rotating assembly 375.

In the subsequent phase, the work surface 361 is lifted (arrow f361),

Figure 9D) together with the suction mouth 379 to reach a working height. The mouth 379 is aligned vertically with the pick-up member 387 carried by the slide 383, said pick-up member having moved from the position in Figure 7 to reach the position vertically above the mouth 379.

At this point the mouth 379 is raised with respect to the surface 361 to come into contact with or in any case in proximity to the member 387, as shown in Figure 9E. The elastic band B of the article M remains engaged between the suction mouth 379 and the pick-up member 387. The fingers 395 carried by the slider 393 have been moved toward one another and carried to the band B of the article M.

At this point (Figure 9F) the mouth 379 is lowered while still engaged with a border of the elastic band B, which is also engaged with the member 387, so that the elastic band is opened. Having reached this position, the fingers 395 are inserted inside the open elastic band (Figure 9G).

The mouth 379 and the pick-up member 387 are at this point withdrawn, to allow the fingers 395 to spread in order to clamp the elastic band B against the brackets 397 (Figures 9H and 9I). In this way, the elastic band B of the article M is firmly engaged and can be inserted over the tubular member 377 with a movement in the direction f393 of the slider 393 (Figure 9J).

The slider 393 moves along the tubular member 377 until the article M in the position in Figure 9K, with the toe P of the article M approximately at the end of the tubular member 377. The slider 393 moves farther to the left to release the fingers from the article and allow a return movement of the slider toward the position in Figure 9A, to allow the tubular member 377 to rotate together with the rotating assembly 375 to transfer the article M thus inserted over said member toward the subsequent station 430, which shall be described hereunder.

In the sequence illustrated in Figures 9A to 9K the pair of tubes 399 mounted on the oscillating plate 401 are not used, as these members come into play only when the articles M to be handled must be reversed, for example if they are socks delivered from a single cylinder circular machine. Likewise, the member 385 is not used in this sequence, but only the member 387 above it.

Instead, when the articles M are socks delivered from a single cylinder machine, which must be reversed before being inserted over the tubular member 377, the operating sequence also comprises the use of the tubes 399, as shown in the operating sequence represented in Figures 10A to 10T.

In Figure 10A the article M has been translated on the work surface 361. The positioning device 369 has engaged the toe P of the article and draws it in the direction of the arrow f369 toward the tubular member 377 until the elastic band B of the article M is positioned over the suction mouth 379 (Figure 10B). The slider 403, which similarly to the slider 393 has four expandable fingers 406 cooperating with brackets 408, equivalent to the fingers 395 and to the brackets 397, is translated in the direction of the arrow f403 to be positioned approximately at the suction mouth 379. The pick-up member 385 (Figure 7) is then made to advance until it is above the suction mouth 379, as shown in Figure 10C. The mouth 379 is also raised, so that the band B of the article M is engaged between the pick-up member 385 and the suction mouth 379 (Figure 10D).

After engaging two opposite borders of the band B by suction, the suction mouth 379 is lowered slightly to stretch the elastic band B (Figure 10E). The fingers 406, which for this purpose have been moved toward one another, as shown in Figure 10F, are inserted in the stretched band. Having reached this position the suction mouth 379 can be lowered (Figure 10G) and the member 385 retracted (Figure 10H) to allow the fingers 406 to spread apart and engage the band B of the article M against the brackets 408. It is thus possible, with a movement in the direction of the arrow f403 (Figure 10I) to insert the article M over the tube 399 which is in the lower position, until reaching the position in Figure 10J.

Suction is activated inside the lower tube 399 over which the tubular article M has been inserted, while the slider 403 is made to translate in the opposite direction of the arrow f403 in Figure 10K. The toe P of the article is thus gradually sucked inside the tube 399, so that the article M is reversed remaining with the elastic band B thereof on the outside of the tube 399.

In Figure 10L the article M is released by moving the fingers 406 toward one another, said fingers (Figure 10M) being then made to move backwards by moving the slider 403 (Figure 10M) in the direction of the arrow

f403. Once the fingers 406 have been spread completely (Figure 10N) the slider 403 again translates to the left to free the tube 399 over which the article is inserted with the elastic band B engaged on the outer surface of said tube and the toe P sucked inside it. This allows (Figure 10P) rotation through 180° of the plate 401 on which the tubes 399 are carried. In this way, the positions of the two tubes 399 are exchanged and the tube over which the band B of the article M is inserted is in the upper position, aligned axially with the tubular member 377 of the rotating assembly 375 which is in the position to receive the article M.

Transfer of the article M from the tube 399 to the tubular member 377 takes place by means of the slider 393, the fingers 395 and the brackets 397 already described hereinbefore. When the machine is set up to process tubular articles M coming from a single cylinder circular machine, the positions of the brackets 397 and the fingers 395 are exchanged with respect to the previous case illustrated in Figures 9A to 9J. This can be seen in the Figures 10Q to 10T.

In Figure 10Q the slider 393 has moved above the tube 399 with the fingers 395 spread apart. The fingers 395 are then moved toward the outer surface of the tube 399 so that movement in the direction of the arrow f393 (Figure 10R) causes the fingers to be inserted under the elastic band B which surrounds the outside of the tube 399. For this purpose the free end of the tube 399 can be provided with projections or tabs which facilitate insertion of the fingers between the band B of the article and the outer surface of the tube 399.

Subsequent spreading of the fingers 395 against the brackets 397 clamps the band B, so that subsequent movement of the slider 393 in the direction of the arrow f393 (Figure 10S) allows the band B of the article M to be transferred onto the tubular member 377 of the rotating assembly 375 standing by in the loading position. By moving the slider 393 farther in the direction of the arrow f393 (Figure 10T) toward the vertical axis of rotation of the rotating assembly 375 the article M is inserted over the outside of the tubular member 377 to take the same position taken by the article M in Figure 9K of the sequence described previously.

From the sequence illustrated in Figures 9 and 10 it is apparent that,

irrespective of the type of sock handled by the machine, this is in any case inserted over the outside of the tubular member 377 which is in the loading position in the station 428 with the toe P of the article adjacent to the free end of the tubular member 377. Rotation through 90° of the rotating assembly 375 then carries the article M inserted over the tubular member 377 to the subsequent station 430.

In the station 430 the article M is oriented about the axis of the tubular member 377 to take the toe pocket and/or the heel pocket to a predetermined position, to allow subsequent sewing of the toe in the correct orientation with respect to these pockets of fabric. Subsequent rotations through 90° carry each article M inserted over the respective tubular member 377 to the preparation station 432 and to the station 434 for extraction and insertion in the guide of the sewing machine 303.

The stations 430, 432 and 434 shall be described in detail individually hereunder.

As described with reference to the operations performed by the machine to feed the individual articles M toward the loading station 428, the articles which are not disposed on the conveyor 327 in the correct direction for the subsequent operations to be performed on said article, are discarded through the pneumatic circuit 341. This circuit may terminate in a device (not shown) disposed over the container 301, which unloads the articles into the container 301 in an orderly way. A device of this type is described for example in the US patent N. 4,099,789. This device can be disposed so that the articles are unloaded into the container 301 basically so as to take a radial position with one or other of the two ends (band B or toe P) oriented toward the outside and the other toward the inside. The end oriented toward the outside will be the one that will most probably be engaged by the pick-up members 305 at the next opportunity. In this way the probability of the discarded article being picked up correctly during the subsequent cycle is increased.

Figures 39 to 44G show a different embodiment of the machine, which differs from the previous one essentially by a simpler structure of the means to load the articles onto the tubular members 377 of the machine. Moreover, in this embodiment the machine has five stations and the rotating assembly

375 advantageously has five separate tubular members 377. The five stations are: the loading station 428; a reversing station 429, in which articles delivered from single cylinder circular machines are reversed; the stations 430, 432 and 434 having similar functions and structure as the stations 430, 432 and 434 of the machine represented in Figures 1 to 10.

In the version in Figures 39 to 44G the machine, again indicated as a whole with 300, comprises a basket or container 301 to which the tubular knitted articles M to be sewn are fed. The basket 301 is located essentially under the rotating assembly 375 carrying the tubular members 377 and rotates about its vertical axis. The sewing machine is again indicated with 303. Figure 39 shows a complete and simplified plan view of the machine, while Figures 40 to 43 show details of the loading station 428. The details of the remaining stations are described hereunder.

The articles M are picked up individually by two pick-up devices 305 similar to the pick-up devices described hereinbefore, provided with pneumatic or mechanical grippers, or other pick-up members 307. The pick-up devices 305 may also be more than two, if this is required by the rate at which the sewing machine 303 works, again in view of the fact that the articles M picked up by the pick-up devices 305 are fed to the subsequent stations only if they are oriented correctly, while articles oriented in the opposite direction are simply returned to the basket 301.

Associated with the two pick-up devices 305 is a unit 501 to open the articles, the structure and function of which shall be described in detail hereunder with reference to Figures 40 to 43.

The unit 501 has a double conformation, to handle the articles M engaged by one or by the other of the pick-up devices 305.

The unit 501 has a load-bearing structure 503 in the shape of an upside down U, connected at the upper end of which is an upright 504 carrying the members to guide and control the pick-up devices 305. Mounted at the other end of the upside down U-shaped structure 503 is a rectangular frame 505 carrying two pairs of optical sensors 507 disposed on opposite sides of the path along which the pick-up members 307 of the pick-up devices 305 travel. In substance, each pick-up device 305 passes between a transmitter and a receiver of the respective pair of arrayed optical sensors

507. These optical sensors have the function of detecting the passage of the lower end of the tubular knitted article engaged by the respective pick-up member 507. These sensors are designed so that they recognize whether the lower end of the article (that is the end in the rearmost position with respect to the direction of feed of the article) is represented by the band B or by the toe P of the article. This discrimination is obtained in a similar way as described previously with reference to the detection station 329, thanks to the fact that the toe end P of the article M is surrounded by a band which differs in color with respect to the color of the article as a whole. In practice, the arrays of sensors 507 can comprise several sensors, each designated with a specific function (detecting passage of the ends, detecting color).

Two arms 509 oscillating about the common horizontal axis X-X are hinged in proximity to the lower area of the structure 503 (see in particular Figure 42). Each arm 509 carries a pick-up member 511 analogous to the pick-up member 385 described with reference to the embodiment in Figure 1 to 10. Each pick-up member cooperates with a suction mouth 513 similar to the suction mouth 379 described hereinbefore. Each suction mouth 513 is provided with a movement in the direction of the double arrow f513 controlled by a respective piston-cylinder actuator 515.

As will be explained hereunder, with reference to the sequence in Figures 44A-44G, when an article engaged by one of the pick-up members 307 is in the correct position for further handling, the lower end thereof is engaged by the pick-up member 511 and by the corresponding suction mouth 513 and is slightly stretched in the same way as described previously with reference to the action of the equivalent members 385 and 379. Subsequently, the oscillating arm 509 whose members 511, 513 have engaged the band of the article, rotates through 90° to carry the band of said article, partially open and held by the members 511, 513, in front of a device to stretch and insert the article over the tubular member 377 which is at that instant in the station 428. This device, essentially identical to the device 395, 397, 393 illustrated in Figures 1 to 10, is shown in detail in Figures 43A to 43E and is indicated as a whole with 517.

The device 517 is carried by a slider 519 connected to a belt 521, driven around two pulleys, one of which is motorized by means of a motor

523, to impart to the slider 519 alternate motion in the direction of the double arrow f519. The driving pulleys of the belt 521 and the motor 523 are carried by a plate 525, integral with a slide 527. The latter slides along a guide 529 carried by a fixed supporting structure 531. The movement of the slide 527 in the direction of the double arrow f527 along the guide 529 is imparted by a motor 533 by means of a threaded bar 535 (see Figures 42B, 43C, 43D).

The movement imparted by the motor 523 allows the device 527 to be translated in front of one or other of the pairs of pick-up members 511, 513 carried by the two oscillating arms 509, to pick up the article engaged by one or other of said pairs and transfer it onto the tubular member 377 which is at that instant in the loading station 528.

The device 517 has four fingers 541, 543. The fingers 541 are carried by curved arms 545 movable with a movement toward and away from one another in the direction of the double arrow f545 to reciprocally move toward and away from one another. The arms 545 are carried by slides 547 sliding in guides 549. The two slides 547 carry brackets 551 to which the fingers 543 are connected. The bracket 551 move with alternate motion in the direction of the arrow f551 controlled by respective actuators 553. The movement in the direction of the arrow f551 allows the fingers 543 to move toward and away from the respective fingers 541. The combined movement of the slides 547 (arrow f545) and of the brackets 551 (arrow f551) consequently allows the fingers 541 and 543 to move toward and away from each other.

In the spread apart position the fingers 541 and 543 rest against seats produced in two corresponding brackets 555. Figures 42B, 43A, 43C and 43E show the fingers 541 and 543 in the position fully spread apart resting against the corresponding seats of the brackets 555. Instead, Figures 43B and 43D show the same fingers 141 and 543 moved reciprocally toward one another. In this position they are inserted inside the slightly stretched band B of the tubular article M held between the suction mouth 513 and the suction member 515. Subsequent spreading apart of the fingers in the position in Figures 43C, 43E dilates the elastic band of the article until it is taken out of the area of the circular section of the tubular member 377, so that a movement in the direction of the arrow f519 of the device 517 carries the elastic band B of the article around the tubular member 377. By moving the fingers 541 and 543

toward one another the band of the article can then be released onto the outer surface of the tubular member 377 and by opening the fingers again and carrying the device 517 beyond the free end of the tubular member 517, the latter can be brought in the subsequent station 430 by means of rotation of the rotating assembly 375.

Operation of the members of the station 428 in this embodiment is illustrated schematically in the sequence in Figures 44A to 44G. Both the pick-up devices 305 are lowered cyclically picking up, by means of the pick-up members 307, an article M from the rotating container or basket 301 below. With a lifting movement each article M moves along a feed path thereof and is made to pass in front of optical sensors 507, which identify the lower end of the article, detecting whether this is represented by the toe P or by the elastic band B of the article M, thanks to the different color of the band surrounding the toe with respect to the remaining part of the sock or article M. The machine is programmed so that articles whose lower ends are represented by the toe are simply released by the pick-up member 307 and fall back into the container 301.

Instead, articles M engaged by the pick-up member 307 so that they hang therebelow with the elastic band B disposed under the toe P continue to be handled as shown in the sequence in Figures 44A to 44G. In Figure 44A the pick-up device 305 stops after taking the band B to the height at which the pick-up member 511 and the suction mouth 513 are positioned. The pick-up device 505 represented in Figure 44A can be one or other of the two pick-up devices 305 provided on the machine in this embodiment.

The mouth 513 is moved toward the member 511 (Figure 44B) so that the band B of the article M is engaged between said two members 511, 513. A subsequent movement to withdraw the suction mouth 513 from the pick-up member 511 stretches the elastic band of the article slightly, as shown in Figures 44C and 44D, where Figure 44D is a view according to D-D in Figure 44C.

The article is at this point ready to be engaged with the device 517. For this purpose the arm 509 carrying the mouth 513 and the pick-up member with which the article is engaged must be rotated through 90°. This rotation is represented in the sequence in Figures 44D, 44E and 44F, where Figure 44F

is a view according to F-F in Figure 44E. When the arm 509 is in the position in Figures 44E and 44F, with the mouth 513 of the pick-up member 511 in front of the device 517, the latter (with a movement imparted by the motor 523) is made to advance to carry the fingers 541, 543 which are in the position in Figure 43B and Figure 43D, inside the partly stretched elastic band B of the article M. The mouth 513 is at this point completely withdrawn from the pick-up member 511 and suction through the mouth 513 of the member 511 is interrupted, while the fingers 541, 543 are spread apart to reach the position in Figures 43A and 43E, in which the elastic band B of the article M is firmly engaged between said fingers and the brackets 555.

At this point the device 517 can be moved toward and around the tubular member 377 to take the position in Figure 44G. The fingers 541, 543 can be partly reclosed and the device 517 can translate farther along the axial extension of the tubular member 377 to unload the tubular article M which engages with the elastic band B on the outer surface of the tubular member 377. The fingers 541, 543 are then spread and the device 517 returned to a withdrawn position with respect to the tubular member 377 which can rotate to the subsequent station 430 of the machine.

With the operations described above the article M is inserted over the tubular member 377 in the reversed position if the article is delivered from a double cylinder circular knitting machine. When the article M is delivered from a single cylinder machine and, consequently, is not reversed, before reaching the stations 430, 432 and 434 it must be reversed. While in the previous embodiment the two tubes 399 were provided for this purpose in the same loading station 428, in this embodiment reversing of the article is obtained in the secondary station 429 (Figure 39). This station is idle when the machine is handling tubular articles delivered from a double cylinder machine, while it operates when the machine is handling articles delivered from a single cylinder machine.

The station 429 is represented purely schematically in Figure 39 and the main components thereof are shown in an axonometric view in Figure 45. In substance, it has a secondary suction tube 599 and a device 598 movable in the direction of the double arrow f598 by means of a flexible member 596. The member 598 is a spreading device, essentially equivalent to the member

517 and is used to pick-up the article from the tubular member 377 positioned in the station 429 and transfer it onto the tube 599, provided with suction inside, and which performs the reversing operation in the same way as already described with reference to function of the tubes 399 in the embodiment in Figures 1 to 10. The reversing sequence is not described in greater detail herein as it can be immediately deduced from the description hereinbefore with reference to the station 428 of the embodiment in Figures 1 to 10. The spreading device 598 is provided with a movement of rotation through 180° about a vertical axis X-X (Figure 45), which allows said member in a first phase to engage the band of the article positioned on the tubular member 377 and transfer it to the reversing tube 599 and in a second phase to pick up the article from the reversing tube 599 and transfer it back to the tubular member 377.

Tubular members 377 over which tubular articles M are inserted, reversed and with the toe disposed in proximity to the free end of said tubular member, consequently reach the station 430 described hereunder. The structures and the functions of the stations 430, 432, 434 which can be identical in the two embodiments of the machine described with reference to Figures 1 to 10 and to Figures 39 to 44G, shall be described hereunder.

Figures 11A, 11B, 12, 13 and 14 show in an axonometric view and in a view and partial longitudinal section the station 430 of the machine, while Figures 15A-15E schematically show a sequence of the operations performed in this station in a view according to a plane orthogonal to the axis of the tubular member 377. More specifically, Figures 11A and 11B show the head of the station 430, with parts removed, while the remaining Figures 12 to 14 show the entire station including a transport tube or tubular member 377 on which the article M is disposed.

With initial reference to Figures 11A, 11B the head, indicated as a whole with 200, comprises a ring 201 disposed on which are sensors 203, which can be optical sensors, background suppression sensors or any other type suitable for the application described herein. The ring 201 with its sensors 203 is carried by a plate 205 operated by a piston-cylinder actuator 207. This actuator moves the ring 201 parallel to the axis of a transport tube or tubular member 377 which is temporarily in the station 430 and over which

an article M has been inserted in the station 428.

Disposed coaxially to the ring 201 is a plate 211 supported by the plate 205 and movable coaxially to the ring 201 through the effect of a piston-cylinder actuator 213, for the purposes described below.

The head 200 also includes a pair of arms 215 carrying at the ends thereof wheels 217, omitted in Figure 11A for greater clarity of the drawing, but illustrated schematically in Figures 11B, 12 to 14. In Figures 12 to 14 the wheels 217 are shown rotated through 90° about the axis of the tubular member 377, with respect to the position they actually take with respect to said tubular member 377. The wheels 217 are carried in rotation by a motor 219 using belts, not shown, driven around pulleys 220. A piston-cylinder actuator 223 controls an oscillatory movement of the arms 215 and of the wheels 217 in the direction of the double arrows f217, to bring the wheels 217 into contact with the tubular member 377, or to remove them therefrom, respectively. The oscillation mechanism is shown in Figure 11B.

When the tubular member 377 is positioned in the station 430, the article M has already been inserted at least partially over said tubular member, with the means described previously with reference to the station 428. The wheels 217 are made to oscillate with the arms 215 through the effect of the actuator 223 and made to rotate by the motor 219 in the direction indicated by the arrows in Figure 12. The article M which is engaged between the tubular member 377 and the wheels 217, coated or produced with a material with a high friction coefficient, is stretched over the outer surface thereof.

During this operation, or in advance thereof, the actuator 207 carries the ring 201 to the position shown in Figure 13, with the sensors 203 around the end of the tubular member 377. In this layout the sensors 203 detect the instant in which the end of the toe P of the article M starts to surround the free end around the tubular member 377, as shown in Figure 13. In fact, this figure shows the band F surrounding the end of the toe of the article M which starts to surround the tubular member 377.

During pulling of the article M onto the outside of the tubular member 377 using the wheels 217, to prevent the band F from slipping beyond the end band of said tubular member and being disposed around the outer

surface thereof, when the sensors 203 detect the presence of the band F of the toe P they activate the actuator 213, which thrusts the plate 211 against the front end of the tubular member 377 to block the band F against it, preventing complete removal thereof from the end of the tubular member.

This layout is shown in Figure 14. Here the wheels 217 continue to stretch the article M, the toe P of which is held by the plate 211.

At the end of the stretching operation, the plate 211 is removed to allow the successive angular positioning operations of the article M in the manner described below.

To understand how this orientation takes place in the example illustrated herein, reference should be made to Figures 15A-15D, which schematically show the front end of the tubular member 377, with the article M inserted thereover and the elastic band F surrounding the end of the toe P which is disposed with a portion F1 along a chord of the circular edge of the tubular member 377, and with the remaining portion F2 along the side surface of said tubular member 377. The pocket S of the toe P of the article M is disposed symmetrically with respect to a plane containing the axis of the tubular member 377 and essentially orthogonal to the portion F1 of the band F surrounding the toe P of the article M to be sewn.

In Figure 15A the article M is in a random angular position with respect to the tubular member 377. Disposed inside the latter are four extractable tabs 225 individually indicated with 225A, 225B, 225C, 225D, the objects of which are explained hereunder. The object of the operations described hereunder is to dispose the article M in a specific position with respect to the tabs 225A-225D, to be subsequently engaged in and removed by systems for inserting the article in the guillotine or guide of the sewing machine 303, with the pocket S of the toe P correctly oriented with respect to the sewing line.

For this purpose, the first operation in the station 430 is to rotate the tubular member 377 through 360° about the axis thereof to return it to the position in Figure 15B, identical to the position in Figure 15A. In this rotation one or more sensors 203 are used to identify the position of the band F and, more specifically, the angular position in which the pocket S is disposed is verified. In practice, one or more sensors 203 read the position of the portion F2 of the band F and determine in which of the two angles A and B (in this

example both 180°) the pocket S is located. In the example shown, it is in the area of angle B and offset by an angle α with respect to the position (known) of the tab 225A.

Supposing that the final angular position to be taken by the pocket S on the tubular member 377 is at the level of the tab 225A (although any one of the tabs may be taken as reference), the article M must be made to rotate by an angle equal to 90°+α about the axis of the tubular member 377. For this purpose, in the station 430 or in the phase to transfer the tubular member 377 from the station 430 to the subsequent station 432, the tubular member 377 is made to rotate through 90°+α about the axis thereof and takes the angular position in Figure 15C.

The subsequent station 432, shown in detail in Figures 16 to 18, has two pairs of jaws 231 which close around the tubular member 377 withholding (thanks to their friction coefficient) the article M, while the tubular member 377 is rotated through 90°+α in the opposite direction from the direction of the previous rotation of the same degree (passage from Figure 15B to Figure 15C). The tab 225A is thus returned to the initial position (Figure 15A), while the article M, held by the jaws, remains in the original position (Figure 15C). The pocket S of the toe P is thus centered with respect to the tab 225A.

The station 432 has a head 233 (Figures 16, 17, 18), with an aligning member 235 which has the function of aligning the band F of the toe P along a line lying approximately on a plane essentially orthogonal to the axis of the tubular member 377, unloading the portion F1 of said band from the circular front edge of the tubular member 377. This aligning member 235 has four arms 237, disposed at 90° from one another and in phase with the tabs 225A, 225B, 225C, 225D. Only two of said arms 237 are shown in the figures in order to simplify the drawing. Each arm 237 carries an oscillating lever 239 hinged in 241 to the respective arm 237 and equipped with a front pad 239A. An actuator 243 operates each of the levers 239. Moreover, each arm 237 carries a sensor 245 similar to the sensors 203.

The entire aligning member 235 is provided with a translatory movement parallel to the axis of the tubular member 377, controlled by a stepping motor 247 and by a screw 249.

When the tubular member 377 is in the station 432, as shown in Figure

16, and the article M has been oriented angularly as shown in Figure 15D, the aligning member 235 is operated to make the portion F1 of the elastic band F surrounding the opening of the toe P of the article slide from the front edge of the tubular member 377 to the side surface thereof. For this purpose the aligning member 235 is made to translate toward the tubular member 377 by means of the motor 247, until the sensor 245 associated with the arm 237 aligned with the tab 225A identifies the presence of the fabric. When this occurs, a signal is generated which, by means of a control unit, not shown, controls oscillation of the respective lever 239 toward the surface of the tubular member 377. The pad 239A grips the fabric of the article M and, continuing movement of the aligning member 235 toward the tubular member 377, causes the portion F1 of the band F to be unloaded onto the side surface of the tubular member 377.

Continuing to reciprocally move the tubular member 377 and aligning member 235 toward each other, as the remaining three sensors 245 detect the presence of the fabric of the article M they control oscillation of the respective lever 239 toward the tubular member 377. In this way, the band F of the article M is engaged in four points by the four levers 239 which align these points and therefore the entire band F on a plane approximately orthogonal to the axis of the tubular member.

Instead of sliding the article M onto the outer surface of the tubular member 377 the entire operation can be performed on the edges of the four tabs 225A-225D, which can be extracted in advance with respect to the movement of the aligning member 235, to take the position shown in Figure 18. This position can also be taken if the tabs are extracted after the aligning member 235 has completed its aligning function. The position in Figure 18 is also shown in a schematic front view in Figure 15E.

Subsequently, the head 233 is moved away from the tubular member 377, after opening the levers 239, to allow transfer of the tubular member 377 toward the subsequent station 434, in which the article is removed from the tubular member and inserted in a guide or guillotine of the sewing machine 303.

Figures 19 to 37 show the structure and operation of the station 434, in which the toe of the article, previously oriented angularly about the axis of the

tubular member 377 over which the article M is inserted, is picked up and taken to a flat or linear position, to be inserted in a guide or guillotine of the sewing machine.

The station 434 comprises a head indicated as a whole with 11 and having a pick-up member to engage – along the edge thereof – the open toe P of the article to be sewn, which reaches the head 11 loaded on the tubular member 377 from the station 432.

The head 11 comprises four elements to engage the toe of the article, each of which is indicated with 13 and has a plate 15, associated with which is a row of needles 17 (Figures 26 to 28) with respective control members which shall be described hereunder. The needles 17 engage (as shall be described in greater detail with reference to Figures 35 to 37) a row of stitches along the edge of the toe to be sewn of the tubular article M.

As can be observed in particular in the plan view in Figure 23, the engaging elements 13 are hinged together along hinge axes parallel to the axis A of the tubular member 377. The engaging elements 13 can take an open configuration, wherein they are disposed along the sides of a square. The plates 15 define in this way a sort of parallelepiped with a square base. This configuration is shown in particular in Figures 19 to 23. The center of the square lies on the geometric axis A of the tubular member 377 which is temporarily in the station 432.

By moving two opposite vertices of the square formed by the engaging elements 13 toward each other the configuration is modified, changing from the aforesaid square layout to a flattened layout, in which the engaging elements 13 are aligned with each other in twos, and the two pairs of aligned engaging elements 13 are opposite each other. This flattened configuration is shown in particular in Figures 24 and 25.

The movement of the engaging elements 13 to pass from one to the other of the two configurations described is controlled by means of a pair of piston-cylinder actuators 19, carried by a fixed structure (not shown) and the piston rods 19A of which are connected to respective supports 21, hinged on each of which are two of the four engaging elements 13. With this arrangement the extending and retracting movement of the actuators 19 cause the opposite hinge axes of the engaging elements 13 to move

respectively toward and away from each other, consequently passing from the open configuration (Figures 19 to 23) to the closed and flattened configuration (Figures 24, 25).

Each of the supports 21 also supports a respective piston-cylinder actuator 23, fixed to the piston rod 23A of which is a bracket 25 which in turn carries a further piston-cylinder actuator 27. The piston rod 27A of each of the piston-cylinder actuators 27 is connected to a respective rectilinear bar 29 extending in a direction oriented through 90° with respect to the direction of the axis A of the tubular member 377. As shall be apparent hereunder, the two bars 29, cooperating with each other thanks to the movement imparted by the actuators 23 and 27, perform the function of stretching the tubular article M in the direction of the longitudinal extension thereof, parallel to the axis A of the tubular member 377, to facilitate insertion in the guide that will subsequently transfer it to the sewing machine 303.

Each of the engaging elements 13 has a configuration which will now be described with specific reference to Figures 26 to 29. The engaging elements 13 are essentially identical to each other, except for the plates 15, the dimensions of which are different. Consequently, only one of these elements will be described hereunder.

Each plate 15 forming the principal body of the respective engaging element has a central portion 15A of greater thickness, which houses a series of members described hereunder, and a lower portion 15B of lesser thickness. Arranged at the lower end of the portion 15B of the plate 15 is a plurality of holes 33 aligned with the edge of said plate. The needles 17, provided in a number and position corresponding to the number and position of the holes 33, can be inserted in these holes 33. The needles 17 associated with each plate 15 are carried by a bracket 35, movable in a direction orthogonal to the extension of the corresponding plate 15. Movement is guided by means of guides 37, integral with the plate 15, and is controlled by a piston-cylinder actuator 39 housed in the portion 15A of greater thickness of the plate 15. In Figure 27 the piston-cylinder actuator 39 is shown in the extended position thereof, at the level of which the brackets 35 carrying the needles 17 are distanced with respect to the plates 15 carrying them and the needles 17 are consequently withdrawn from the holes 33. When the piston-

cylinder actuator 39 is retracted the respective bracket 35 is taken to the closed configuration with the needles 17 inserted in the holes 33 by means of compression springs 41 arranged about pins 43 screwed into blind threaded holes 45 produced in the portion of greater thickness 15 of the respective plate 15 (see in particular Figure 28).

Mounted on each bracket 35 is an extractor 47 stressed in the position shown in Figures 26 to 28 by means of compression springs 49 (Figure 27). Each extractor 47 has holes 51 corresponding in position and number to the needles 17 carried by the respective bracket 35. In this way, the needles 17 can penetrate and pass through the respective extractor 47 to penetrate the holes 33 when the bracket 35 is thrust by the springs 41 against the supporting plate 15. This closing movement of the brackets 35 with respect to the plates 15 also causes compression of the springs 49 when the extractor 47 comes to rest against the portion 15B of the respective plate 15.

Immediately above the extractors 47, integral with the portions 15B of the plates 15 are stops 55, the purpose of which, as shall be explained hereunder, is to align the borders or edge portions of the toe of the article according to a straight line before said article is inserted in a guide or guillotine 61 which will transfer the article to the sewing machine 303, aligning itself with the guide or guillotine thereof.

The head 11 is completed by two secondary units 63 carrying secondary elements to engage the ends of the flattened toe of the article. Each unit 63 is carried by a support 65 integral with a load-bearing structure, not shown. Connected to the support 65 are guides 67, sliding along which is a slide 69 carrying a piston-cylinder actuator 71. As can be seen in particular in Figure 29, each slide 69 is hinged to a corresponding plate 15 of one of the engaging elements 13. In this way the piston-cylinder actuators 19 which control modification of the configuration of the engaging elements 13 also cause a sliding movement of the slides 69 in the direction of the double arrow f69 along the guides 67 to follow the oscillating and translatory movement of the plates 15.

The piston rod 71A of each piston-cylinder actuator 71 is connected to a block 73 carrying a needle 75 forming a secondary engaging element of the end of the edge of the toe of the article when this has been taken to the

flattened position by closing of the engaging elements 13, as shall be better explained hereunder.

The movement to radially extract and axially translate the tabs 225 with respect to the tubular member 377 to allow extraction through the grooves 7 in the cylindrical wall 5 of said member and to axially withdraw them beyond the end of the tubular member 377 is obtained with the mechanism illustrated in detail in Figures 30 to 33. The tabs 225 are each provided with a pair of slots 225E inclined with respect to the rectilinear edge 225F of the respective tab parallel to the axis A of the tubular member 377. Besides the two inclined slots 225E, each tab 225 has a slot 225G essentially extending radially.

Engaged in the radial slots 225G are pins 81, integral with a block 83 clamped on a rod 85 of a piston-cylinder actuator, not shown. The translatory movement of the rod 85 in the direction of the double arrow f85 parallel to the axis A of the tubular member 377 causes axial sliding of the group of tabs 225, which can in this way be extracted from the upper end edge of the tubular member 377 through slots produced in a front closing cover of the tubular member 377.

The block 83 has four through holes through which four corresponding bars or columns 87 extend, connected to a ring 89 and sliding in the holes produced in said block 83. Above the block 83 the columns 87 are connected to sectors 89 provided with pins which are inserted in the inclined slots 225E. A translatory movement in the direction of the arrow f87 of the bars or columns 87 parallel to the axis A of the tubular member 377 consequently causes a radial extracting movement of the tabs 225 due to the inclination of the slots 225E, in which the pins integral with the sectors 89 engage. By operating the rod 85 and the bars or columns 87 separately, the movements to radially extract and axially withdraw the tabs 225 with respect to the tubular member 377 are both obtained.

Having described the mechanical structure of the members of which the station 434 is composed, the operation thereof shall now be described with specific reference to Figures 34 to 38.

The article M has been inserted over the tubular member 377 in the station 428 and oriented correctly, with respect to the tubular member 377, in the stations 430 and 432. It is then stretched and partially withdrawn with

respect to the member 377 to take, with respect to the head 11, the position in Figure 34. The edge surrounding the toe P of the article takes a quadrangular arrangement, as shown in Figure 35. Figure 34 also shows the head 11 of the station 434, with the article M partially extracted from the tubular member 377. The four borders disposed according to the sides of a square of the edge of the toe P of the article M are inserted between the portions 15B of lesser thickness of the four plates 15 and the respective four rows of needles 17 carried by the brackets 35 of the respective elements 13. For this purpose the brackets 35 have been taken to the open position through extension of the four respective piston-cylinder actuators 39. The four extractors 47 associated with the four series of needles 17 of the four engaging elements 13 are also distanced with respect to the ends 15B of lesser thickness of the respective plates 15, leaving sufficient space to insert the edge of the toe P until it comes into contact with the stops 55. The axial extraction movement of the tabs 225 is sufficient to cause contact of the entire edge of the toe P of the article M on the stops 55 of the four plates 15, so that the edge is disposed on a plane orthogonal to the axis A of the tubular member 377 even if it was not initially aligned therewith.

Having reached this position the actuators 39 retract to allow the brackets 35, under the thrust of the compression springs 41, to move against the plates 15 with consequent insertion of the needles 17 in the fabric of the toe. Each series of needles 17 carried by one or other of the four brackets 35 is inserted in the corresponding border of the toe of the article M held in a rectilinear position by two adjacent tabs 225. With this closing movement the extractor 47 comes into contact with the thinned portion 15B of the respective plate 15 pressing against the fabric of the article M. Once the brackets 35 have closed under the thrust of the compression springs 41, the tabs 225 are withdrawn from the article and retracted fully inside the tubular member 377.

In the subsequent phase the piston-cylinder actuators 19 extend to cause the engaging elements 13 to move from the square configuration (shown in the plan view in Figure 23) to the rectilinear configuration shown in the plan view in Figure 25. The position taken by the engaging elements 13, by the members associated therewith, and by the fabric of the article M in this phase is shown in Figure 36.

The bars 29 have been closed to clamp the fabric of the article M immediately below the area engaged by the four series of needles 17 carried by the four engaging elements 13. Closing in the flattened configuration of the engaging elements 13 has also caused the secondary needles 75 to penetrate the two end points of the edge of the toe of the article which has been folded by moving the two opposite pairs of plates 15 reciprocally toward each other. The secondary needles 75 also have a movement parallel to the longitudinal axis thereof, to be easily inserted in and extracted from the knitted fabric forming the article. This movement is obtained with respective piston-cylinder actuators 91 housed in the corresponding blocks 73.

These needles 75 can be lifted by means of the piston-cylinder actuators 71 once they are engaged in the fabric of the article, from the position to pull the fabric upwards, with respect to the bars 29, in the end points of the folded and flattened edge of the toe.

In the subsequent phase shown in Figure 37 the bars 29 are moved away from the engaging elements 13 by means of the actuators 23 to tension the portion of textile article between the needles 17 and said bars 29. This portion of tensioned fabric can at this point be inserted in the guide 61 which can be provided with a translatory movement below the group of engaging elements 13, between them and the bars 29. Alternatively, it can be the head 11 which translates laterally in a direction parallel to the alignments of needles 17, toward the guide 61.

The article can at this point be released by extending the piston-cylinder actuators 39 and then withdrawing the needles 17 from the fabric of the article, said withdrawal being facilitated by the action of the extractors 47. The secondary needles 75 are also withdrawn by means of the respective actuators 91. The article is released completely by opening of the bars 29 by means of the actuators 27. Removal of the article from the head 11 takes place by moving the head 11 and the guide or guillotine 61 away from each other. Preferably, the movement is made by the latter. In this way the edge of the toe is removed from the area of the plates 15. Subsequently the guide 61 is made to translate parallel to the longitudinal extension thereof to remove the article M from the operating area of the device and rotate it through 90° by means of an actuator 64 (Figure 2) to take it in alignment with a guide 62

(Figures 1 and 2) of the sewing machine 303. Withdrawal of the article from the tabs 225 and/or from the tubular member 377 can take place with the aid of jaws or other equivalent means, known and not shown herein.

Opening of the engaging elements 13 by the actuators 19 returns said elements to the spread apart configuration to receive the subsequent article.

Translation of the article along the guillotine guide 61 to the guide 62 of the sewing machine 303 and therealong to the needle of the sewing machine takes place in a known way.

The individual stations and the relative members of which they are composed can also be used individually, or in different combinations with respect to those shown. For example, one or more of the stations described and illustrated can be replaced by an operator. Therefore, the present invention also relates separately and individually to each station and each operating member or head of each station considered separately, which are intended herein as described also as an individual and separate element, or in combination with only part of the remaining stations, or in combination with stations of a different configuration to perform identical, similar or different operations with respect to those described herein.

It is understood that the drawing merely shows an example provided purely as a practical demonstration of the invention, the forms and arrangements of which may vary without however departing from the scope of the concept on which the invention is based. Any reference numerals in the appended claims are provided for the sole purpose of facilitating reading in the light of the description hereinbefore and the drawing, and do not limit the scope of protection represented by the claims.